Draft List and Evaluation of Potential BDCP Analytical Tools

Note: The following table describes analytical tools identified by the Analytical Tools Technical Team that are available and suitable for use by other working groups and technical teams conducting analyses in support of conservation measure development. The Team will update this table as additional analytical tools are identified or become available. With the concurrence of the Steering Committee, the Team will distribute this table to the appropriate working groups and technical teams and, as requested, provide support with the application of the tools.

Tool Type	Name	Applications	Key Assumptions and Uncertainties	Level of Acceptance/Peer Review	Caretaker
Hydrology/ System Operations	CALSIM II	System and Delta operations (incl. reservoirs, flows, X2, E:I, QWEST, OMR, salinity)	Monthly input, 82-yr simulation, mass-balance, ANN-approximation of salinity/X2	Peer-reviewed, issues raised, but best tool available	DWR
	CalLite	System and Delta operations (incl. reservoirs, flows, X2, E:I, QWEST, OMR, salinity)	Monthly input, 82-yr simulation, mass-balance, ANN-approximation of salinity/X2, limited hydrology detail in Sac Valley	Limited, based on the early-stage of the tool	DWR/ USBR
	Yuba River Basin Model	HEC-5 model: includes inflows, demands, and fisheries flow requirements; monthly time step	Like CALSIM II it relies on mass balance reservoir routing logic; used for Yuba River, not the Delta	TBD	TBD
Hydrodynamics/ Water Quality	DSM2	Delta hydrodynamics, salinity, gate operations	1-D, 15-min, 16- to 82-yr simulations	Peer reviewed, no 2-D capabilities, dispersion approximated	DWR
	RMA	Delta hydrodynamics, salinity, gate operations, levee failure and flooded islands simulation, residence time, particle transport	2-D depth averaged and 1-D, medium duration simulations (up to 16 yrs), can be run with full Bay-Delta or Delta only configuration	Basic finite element formulation available in peer reviewed literature and conference proceedings, application to SF Bay-Delta documented in reports to CALFED and DWR	RMA

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	RMA Tidally Averaged Delta Transport Model (component of DRMS Water Analysis Module)	Tidally Averaged Delta flow and salt transport, gate operations, levee failure simulation	Simplified 1-D geometry based on full RMA model, calibration of tidally averaged dispersion coefficients based on 3-D results, very fast simulation	Basic finite element formulation available in peer reviewed literature and conference proceedings, configuration and application for the Delta is documented in the DRMS report on the Water Analysis Module, new model and not yet fully accepted	RMA
	Si3D	Delta hydrodynamics, salinity, gate operations	2-D, short duration simulations	TBD	Pete Smith, USGS
	Trim2D	Delta hydrodynamics, salinity, gate operations	2-D, short duration simulations	TBD	Cheng, Smith
	Trim3D	San Francisco Bay and Western Delta hydrodynamics, salinity,	3-D, short duration simulations, focus of model is Bay and Western Delta, interior of the Delta is represented as simple channels with equivalent tidal prism, regular grid	Model formulation and application to SF Bay is peer reviewed.	Ed Gross
	Reclamation Water temperature model	Water temperatures in Sacramento, Feather, and American rivers	Have both reservoir and river components for predictions	TBD	Bureau of Reclamation
	DRMS Delta model	TBD	TBD	TBD	RMA
	DWR Particle tracking work	Estimates entrainment of neutrally buoyant particles as a function of Old & Middle rivers flow and QWEST	TBD	TBD	DWR
Process Models	DRERIP	Identifies restoration actions; Evaluates restoration actions; Identifies unintended outcomes and scores magnitude and certainty (qualitatively) of both positive and negative outcomes	Not all models are complete to date; Those models that have not completed the peer-review process may require consultation with experts during the evaluation process to maintain scientific integrity	High, but not all have been peer-reviewed to date	Brad Burkholder/ Steve Detwiler

Tool Type	Name	Applications	Key Assumptions and Uncertainties	Level of Acceptance/Peer Review	Caretaker
	Viable Salmonid Population framework (VSP)	Determines viability of salmonid populations based on key demographic variables: abundance, population growth rate/productivity, spatial structure, and genetic variability	May require outside experts; may need to be deconstructed for BDCP purposes (Delta-specific); applies to individual populations, not entire ESUs	TBD	NMFS
	Population Viability Analysis (PVA); 3 approaches: Leslie matrix, state space models, individual-based	Evaluates the likelihood that a population will persist for a given time into the future; can be used on multiple species if assumptions are met	Major assumptions: (1) accurate population estimates are available; (2) no density dependence; approach used depends on availability of data; many caveats and concerns associated with PVA	High	Multiple
	Delta smelt model (Sitts)	Predicts entrainment of delta smelt at SWP/CVP facilities and relates to population level effects; stage-structured population level model; can explore effects of variation in Old and Middle rivers flows, hydrologic regime, gear efficiency, pre-screen losses, abundance estimates, and survival estimates; Excel-based; daily time step; has hydrologic module	Uncertainty in abundance, survival rates, gear and screen efficiency; based on existing fish data; only deterministic, but stochasticity can be easily added	Unknown (manuscript in preparation)	Rick Sitts
	Winter-run Chinook Integrated Modeling Framework v.2.0	Predicts population-level response to upstream habitat actions, flows, exports, temperatures, DCC gate position, turbidity, ocean harvest, salinity and mark-selective fishery effects; Gold-Sim based; all life stages; Assesses benefits of mark-select fisheries	Uncertainty regarding Sacramento River and Delta survival rates and adult returns; based on existing monitoring data	Unknown (manuscript in preparation); Continually updated with new monitoring data; used by IEP work teams	Cramer Fish Sciences & Rick Sitts

Tool Type	Name	Applications	Key Assumptions and Uncertainties	Level of Acceptance/Peer Review	Caretaker
	Delta Salmon survival model (Newman-Rice)	Predicts survival rates of juvenile salmon in the Delta based on release temperatures, turbidity, flow/salinity, DCC gate position, release location of fish	Not meant as stand-alone model, based on correlations	Published multiple iterations	Newman & Rice
	Reclamation Salmon mortality model	Provides estimates of early life stage (pre-spawned and fertilized eggs, pre-emerging fry) mortality; Sacramento River: fall, late-fall, winter, and spring run, American River: fall run only	Based on temperature model output	TBD	Bureau of Reclamation
	Salmon escapement model (DFG)	Numeric model developed for San Joaquin Basin Fall run Chinook salmon; Describes relationship between San Joaquin River flow and production	TBD	Yes	Dean Marston, DFG
	Sacramento River Ecological Flows Tool (SacEFT)	Decision analysis tool based on conceptual models to evaluate flow based management actions on a set of focal species	Based on upper Sacramento River (upstream of Colusa), needs work to be applicable to Delta; outcomes based on CALSIM output	Unknown (just released)	Ryan Luster, TNC
	SALMOD	Determines effects of physical habitat on salmonid mortality and location	Has been previously applied to each race of salmon on Sacramento River; may be applicable to upstream of Delta only; only sees a linear stream with no tributaries or branches possible	High, multiple publications	USGS

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	Fish salvage model	Calculates direct losses at Skinner Fish Protection Facility and Tracy Fish Collection Facility; uses historical fish salvage data for a specified period of record to construct baseline against which to evaluate alternatives	Direct losses resulting from export operations are function of monthly water exports from each facility and density of fish (number per acre-foot) vulnerable to entrainment	TBD	TBD
Statistical Correlations					
Delta smelt	Exports and San Joaquin flow vs. delta smelt salvage in winter (Guerin et al.)	Identifies relationship between exports, San Joaquin flows and winter delta smelt salvage	Valid for winter adult salvage, relates directly to export and SJR flows for broad periods (monthly averages)	Unknown (manuscript in preparation)	CCWD
	Turbidity vs. delta smelt spatial patterns (Smith)	Identifies spatial patterns of turbidity and delta smelt abundance	Correlation only	TBD	TBD
	Old and Middle River flow vs. adult delta smelt salvage (Manly)	Identifies positive correlation between magnitude of reverse flows and other factors such as Sacramento flow levels and pre-spawned delta smelt adults salvaged during Dec-Jan. Another correlation is valid during Feb-Mar.	Correlation only. Uses previous FMWT or Spring population estimate to normalize estimated salvage.	Unknown (manuscript in preparation)	Brian Manly, Rick Sitts
	Delta smelt percent of population in the southeast Delta	Estimating vulnerability of larval and juvenile delta smelt to entrainment at the pumps.	Correlation only. Abundance estimates.	Unknown (manuscript in preparation)	Bryan Manly, Rick Sitts
	Winter exports or SWP winter salvage of delta smelt vs. subsequent fall midwater trawl for delta smelt (Guerin et al.)	Suggests relationships between winter export level, SWP winter salvage, or SWP winter salvage normalized to prior FMWT for delta and longfin smelt and subsequent FMWT levels for delta and longfin smelt	Requires salvage level or export level, previous FMWT, current Delta configuration, regulatory status	Unknown (manuscript in preparation)	CCWD

Tool Type	Name	Applications	Key Assumptions and Uncertainties	Level of Acceptance/Peer Review	Caretaker
	Summer/fall habitat variables vs. delta smelt (Feyrer et al. 2007, Nobriga et al. in press)	Identifies salinity and turbidity as important physical variables influencing delta smelt occurrence	Depends on spatial scale; based on existing monitoring data	High	Fred Feyrer, Matt Nobriga
	Fish-food vs delta smelt FMWT (Miller et al)	Relates composite of the product of delta smelt population and food level to subsequent FMWT	Need fish and food density by location	TBD	B.J. Miller
	Juvenile mortality vs. various factors	Relates juvenile salvage at CVP/SWP facilities to various factors, all pointing to food limitation at early smelt stages	TBD	TBD	Bryan Manly
	Juvenile salvage vs. zooplankton in south Delta	Links juvenile smelt salvage to zooplankton in the south Delta, implies that food supply may limit smelt population in spring	TBD	TBD	Lenny Grimaldo
	Smelt abundance vs. exports	Attempts to find a correlation between smelt abundance and exports	TBD	TBD	Brian Manly, Mike Chotkowski
Longfin smelt	Winter/spring outflow vs. longfin smelt	Identifies positive relationship between winter/spring outflow and longfin smelt abundance	Mechanism of correlation is unknown; relationship holds up before and after *Corbula* invasion, and potentially during POD	High	IEP
Multiple species	Fish salvage vs. water exports	Predicts monthly salvage of multiple species at SWP/CVP facilities based on export volumes and density of fish	Based on relationships of historical salvage vs. exports and fish density; based on current configuration/ facilities; monthly time step	TBD	DFG/ Reclamation
	Flow index vs. fish index (Swanson et al)	Identifies relationship between normalized composite flow relationship and normalized composite fish index for FMWT species	Uses several common flow parameters, relates to composite fish index	Unknown (Draft)	TBI

Tool Type	Name	Applications	Key Assumptions and Uncertainties	Level of Acceptance/Peer Review	Caretaker
	X2 (Various)	Relates Feb-June location of X2 with subsequent fish population indices	Relates Feb-June X2 to fish population levels, pre- and post-clam	High	Generally available, most recent from IEP
	K-M X2 equation	Predicts X2 location	Estimates current X2 position as a function of Delta outflow and previous X2 position	High	Wim Kimmerer, others
	G-model	Predicts western Delta salinity	Estimates western Delta salinity as a function of antecedent Delta outflow	High	Richard Denton, CCWD
	Suisun Marsh Salinity Control Gates vs. salinity	Indicates effect of Suisun Marsh Salinity Control Gates on salinity when baseline X2 location has already intruded to the confluence or above	TBD	TBD	Wim Kimmerer

TBD = To be determined.